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Climate change impacts in Missouri State Parks: Perceptions from engaged park users

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ABSTRACT

Frequent visitors to natural areas may be more receptive to climate change messages and more likely to act on their environmental values. To aid in developing targeted communication strategies, this exploratory study assessed how engaged state park users perceive climate change impacts and what they view as the agency role in climate change mitigation, education, and communication. Photo elicitation and semi-structured interviews were conducted with 18 members of the Missouri Parks Association (MPA), an advocacy group. While participants expressed concern about the threat of climate change to state parks, some doubted their ability to identify impacts. Despite this, participants accurately identified most of the regional threats predicted by experts, including increased flooding and drought, early blooming, invasive species, and extreme weather. Some reported that participation in the study inspired them to observe climate impacts more closely. Participants affirmed that state parks should lead climate change education and mitigation efforts, while acknowledging the challenges of addressing a politically charged subject. Regarding communication, MPA members recommend focusing on the science behind climate change and ecological mitigation. Although this study focused on Missouri state parks, results may be applicable to visitors in other Midwestern states.

Management implications:

- Study participants supported managerial action on climate change adaptation through education and ecological management.
- They acknowledged the political challenges managers face. This study supports presenting scientific evidence to the public and framing climate-change communication around specific, resource-related impacts, especially vegetation, wildlife, and landscape themes that visitors identify as locally salient.
- Alternatively, park management could focus natural resource-based climate change education on the broader ecological benefits of environmental behavior.
- Staff can also highlighting environmental efforts underway in parks, such as adoption of energy efficient technology and landscape management practices aimed at increasing ecological resilience.
- Staff should be educated, empowered and encouraged to deliver locally-relevant climate change interpretation.

1. Introduction

1.1. Public perceptions of climate change

Despite the scientific consensus around climate change, for much of the public, climate change still seems abstract and controversial (Sheppard, 2012; Weber & Stern, 2011). Previous research indicates that perceptions vary greatly across demographic groups and geographic regions (Howe, Mildenberger, Marlon, & Leiserowitz, 2015) and are influenced by mitigating factors, such as political orientation and beliefs (McCright & Dunlap, 2011; Whitmarsh, 2011) and risk perception (Leiserowitz, 2005). Furthermore, the public may have trouble conceptualizing climate change in places where the effects are not as obvious or newsworthy as in other parts of the world and where news coverage does not link climate change to events and impacts.

Previous studies have validated the potential for using parks and natural areas for climate change education and engagement and have recommended creating locally-relevant, region-specific education campaigns that highlight place and place-related connections to emotional, cultural, and social meanings, using messages that help visitors

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identify actions that can be taken (Schweizer, Davis, & Thompson, 2013; Thompson, Davis, & Mullen, 2013). Other scholars have called for more integration of social and behavioral sciences into the field of climate-change research (Bjurström & Polk, 2011; Dunlap & Brulle, 2015). A number of outdoor recreation researchers have studied perceptions of climate change impacts in parks and natural areas; however, this research often focuses on locations where the effects are acknowledged and dramatic, such as a lake experiencing extreme drought (Brownlee, Hallo, Moore, Powell, & Wright, 2014) or a park where glaciers are visibly receding (Schweizer et al., 2013). Although studies have examined park visitors' perceptions of climate change (Brownlee & Verbos, 2015; Perry, Manning, Xiao, Valliere, & Reigner, 2018; Sharp, Brownlee, Larson, 2012), research has not addressed these impacts in areas where the effects are less apparent (IPCC, 2014). Indeed, Sheppard writes that scientists have only recently begun to model climate change impacts in ways that highlight small-scale, locally-relevant implications and predicts that as people have become more aware of threats to their own communities, "the clamour for better local data is likely to become a deafening roar" (Sheppard, 2012, p. 51).

1.2. Photo elicitation

Photo elicitation projects have shown that engaging local people in collaborative or visual methodologies can create unique conceptualizations of climate impacts and avenues for dialogue (Baldwin & Chandler, 2010; Gustafson & Al-Sumait, 2009). Photo elicitation is a qualitative research technique that allows people to combine photos with verbal descriptions of certain places to provide greater depth, understanding and context, producing "a different kind of information" (Harper, 2002, p. 13). Photo elicitation is used as a way to add a visual element to data collection and to provide a basis for discussion when conducting interviews. Since being developed in the 1950s (Collier, 1957), photo elicitation has been used in many studies as a way to cast ordinary people as experts of their own experience for capturing unique insights (Bennett, 2014a, 2014b; Wang & Burris, 1997). Photo elicitation studies are useful for helping people engage individually and as communities to identify threats and impacts related to climate change (Baldwin & Chandler, 2010; Gustafson & Al-Sumait, 2009; Sherren & Verstraten, 2013). For example, one study used photo elicitation to examine climate change threats related to rising sea levels in coastal communities, with a goal of educating and building capacity for adaptation (Baldwin & Chandler, 2010). In this capacity, photos provided a way for study participants to show specific perceived impacts.

1.3. Local knowledge

A growing body of work examines the ways outdoor recreation visitors interact with the natural world in response to climate change (Hand, Smith, Peterson, Brunswick, & Brown, 2018). Previous studies have found that park visitors are more likely to believe that climate change is occurring (Sharp et al., 2012) and to believe that climate change will affect nature-based tourism destinations (De Urioste-Stone, Scaccia, & Howe-Poteet, 2015) as compared with the general population. Specific experiences at recreation areas may also influence visitors' perceptions of climate change (Brownlee, Hallo, Wright, Moore, & Powell, 2013). Indeed, people who visit natural places appear to be receptive to persuasive climate change messages (Davis, 2014) and more likely to put their environmental values into action (Vaske & Kobrin, 2001). While park visitors may be a target in terms of climate education and action, a further subset of this group may be useful in assessing climate change impacts and aiding in communication efforts. Many state and national parks have "friends" groups made up of devoted park users who take on an advocacy role. These groups provide volunteer services for parks, such as guiding, and support parks through raising money or providing volunteers (Eagles, 2002).

2. Methods

2.1. Study purpose and research design

This exploratory study assessed perceived climate change impacts of engaged state park users and what they view as the state parks' role in climate change mitigation. It is part of a larger, statewide effort examining how Missouri communities manage for climate resiliency.

2.2. Setting and participants

Missouri State Parks and Historic Sites (MSP) was selected to gather knowledge to inform climate adaptation strategies on a local level in a place where climate effects may not be readily apparent (IPCC, 2014). MSP receives approximately 18 million annual visitors, with an estimated economic impact of more than $1 billion per year (Missouri State Parks, 2014). Engaged users of MSP were selected to conduct observations, based on a desire to identify locally-relevant climate change impacts in a sector of great social and economic importance to the state and region. These users were recruited using a purposive critical case sample (Palinkas et al., 2015) from among members of the Missouri Parks Association (MPA), a lobbying and advocacy group comprised of approximately 3000 park supporters who share an interest and involvement in the state park system. Critical case sampling is a method used in exploratory qualitative research using a small number of cases to enable generalization to the overall phenomenon (Palinkas et al., 2015). Because of their membership status, these participants were assumed to have broader knowledge of and experience with state parks than other visitors or the general public. Further, membership in this group might give study participants a unique awareness of climate-related challenges facing the parks. Participants were recruited initially during the MPA annual meeting in October 2015, followed by an additional email invitation sent to the organization's members.

2.3. Data collection

Qualitative data was collected through photo elicitation and follow-up interviews. For the photo elicitation, participants were asked to take 8–10 photographs in Missouri State Park & Historic Sites of their choice that illustrated tangible effects of climate change. For each photo, participants were asked to create a short narrative (caption), including a brief description of the photo, the location where it was taken, and its connection with climate change. Photographs were submitted with captions to the researcher via email. Participants were asked to send photographs and captions from fall 2015 through summer 2016, with the intention of capturing climate impacts in different seasons. A $10 incentive was provided to participants who submitted photos.

Follow-up interviews were conducted in fall 2016 with those who had agreed to participate in the project, whether or not they had submitted photos. Participants were interviewed at a location of their choice, either at their home, a park, or a public venue. Interviews averaged approximately 30 min and used a semi-structured script. In the interviews, participants were asked to describe their pictures, if submitted, and to explain how they represented climate change. Participants were asked what other climate-related impacts they have witnessed in Missouri State Parks and what they perceive as the role of state parks in adapting to climate change effects statewide. A $10 incentive was provided to participants who agreed to be interviewed.

Five participants submitted a total of 34 photos with captions. The photos represented 12 locations across the state (see map, Fig. 1, below); some participants focused on one park, while others submitted photos from several different areas. Four of the original participants who had submitted photos and an additional 13 members agreed to be interviewed, for a total sample size of 18, including one person who submitted photos but declined to be interviewed. The sample was split among females (n = 8) and males (n = 10).

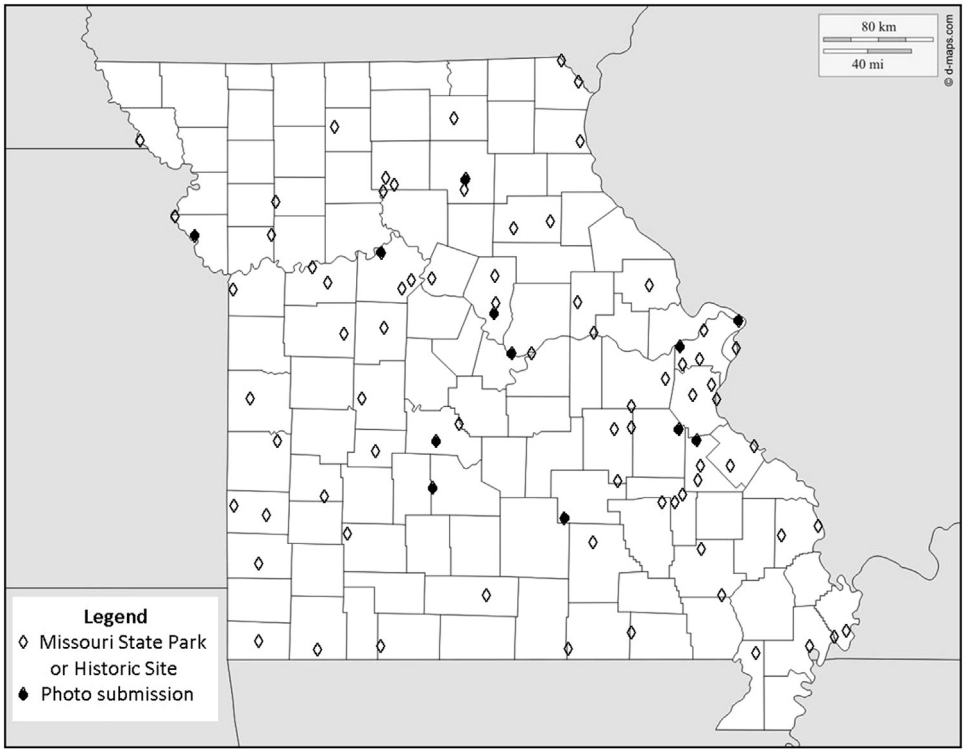

Fig. 1. Map of Missouri showing locations of state parks and historic sites and photo elicitation submissions.

2.4. Data analysis

The photos, captions and follow-up interviews were digitally recorded and systematically transcribed, then coded using NVivo qualitative data analysis Software (QSR International Pty Ltd. Version 10, 2012). As this study was exploratory and aimed at collecting a wide range of interpretations, a general inductive approach was employed to identify emerging themes from the research findings (Thomas, 2006). While working with the raw data, the research team allowed the themes to emerge organically, instead of imposing pre-existing theory. Codes were initially created through independent parallel coding (Thomas, 2006), in which two members of the research team independently developed codes from the raw text after studying the interview transcripts and photograph captions. Following discussion, these categories were merged into one combined set. Finally, two members of the research team conducted dual coding and examined the codes for interrater reliability. Triangulation was employed, seeking information convergence between the different sources and analysis convergence among members of the research team through use of peer debriefing (Creswell & Miller, 2000).

3. Results

The following sections describe emergent themes related to climate change impacts that could be useful in developing targeted communication strategies for park visitors in Missouri (see Table 1, below). Specifically, results are grouped into two categories: observed climate impacts and what participants see as the role of Missouri State Parks in addressing these impacts. Although questions were focused on Missouri state parks, results may be applicable to visitors in other Midwestern states.

3.1. Observed climate impacts

Three main themes emerged related to observed climate impacts: *Challenges, Weather* and *Ecosystems*. Participant *Challenges* included participants finding climate change difficult to visualize and being unsure about impact attribution. Despite these caveats and concerns, numerous climate change impacts emerged in the interviews and photo captions. Within the broad theme of *Weather*, subthemes identified included droughts/floods, extreme weather, seasonal calendar, and temperature. The broad theme of *Ecosystems* included subthemes of vegetation, wildlife, and landscape.

Table 1
Photo-elicitation and interview themes and subthemes by category.

Category	Theme	Sub-themes
Observed climate Impacts	Participant challenges	Difficult to visualize; Unable to attribute
	Weather	Droughts/floods; Extreme weather; Seasonal calendar; Temperature
	Ecosystems	Vegetation; Wildlife; Landscape
Role of Missouri State Parks	Difficult to discuss	Politically controversial; Overwhelming
	Education	Changes over time; On-site data collection
	Management	Demonstration area; Mitigating invasive species; Protecting resources; Protecting water quality; Long-term planning

3.1.1. Challenges

Participants uniformly felt that the impacts of climate change were *difficult to visualize* in Missouri, though they agreed that effects exist, both in Missouri and elsewhere. Participant 16 (F) said, “I think it's very difficult to take pictures of other kinds of climate change that have to do with animals and plants getting out of cycle and habitats becoming more suitable for certain species than others.” Participant 13 (M) captured the notion of understated climate effects in Missouri versus more obviously-impacted areas when he noted, “The effects right now in Missouri of climate change – I’m sure they’re there, but they’re more subtle than if you would go to more northern areas or mountain tops.” Similarly, Participant 2 (M) alluded to the fact that climate impacts are

more visible elsewhere: “If you look beyond Missouri, which I do, the last few years I’ve traveled all over the country. I’ve done consulting work, but there's plenty of signs out there that climate change is taking place.” Furthermore, he said, “I guess as a scientist and somebody that's traveled around, I’m convinced that it's real.”

However, many participants were unwilling or felt *unable to attribute* environmental impacts to climate change. Even some participants with scientific backgrounds were reluctant to specify climate change causation, including several who had kept decades-long records of flower blooming times or rainfall levels. Participant 10 (F), who regularly leads nature hikes and education sessions at one state park, said the project had prompted her to think more about climate change impacts she was seeing, but she continued to question her knowledge. “I’m really struggling with it, and I think you’ve helped me bring it home, but if I were to do a climate change hike at the state park, I’m not sure how I would do it, to link it.” Along the same lines, Participant 4 (M) said that during the project:

> I might see some things and say to myself, ‘Hmm, this could be a sign of global warming, but I am not sure.’ I found myself in the situation where, just due to lack of knowledge that I ought to have as somebody who loves the outdoors and thinks of himself as an observer of the outdoors and an active user of Missouri State Parks, that I ought to know this. But I found that I really didn’t know what I was doing.

Participant 6 (M) summed up the fear of stirring up debate when he refused to definitively attribute any specific impacts to climate change, saying, “You have to have that disclaimer whenever you’re discussing this topic, because you don’t want to appear to be claiming any particular event is a direct result of climate change.”

3.1.2. Weather effects

Droughts and flooding were the most commonly reported weather impact, cited by 10 participants, including participant 15 (M), who noted, “I think in Missouri State Parks, and parks generally, where we see the effects of climate change are as it relates to the frequency, velocity, and extreme flooding conditions that occur.” Droughts were mentioned by several participants in contrast to flooding.

Many participants noted that *extreme weather* events, such as straight-line winds, ice storms and tornadoes, are increasing in frequency. Participant 12 (F) said: “We’re having more violent weather as a result of climate change and that's going to continue, that pattern.” This includes events previously expected to take place once every 100 or even 500 years. For example, regarding an event where many trees were uprooted or broken in a windstorm, Participant 6 (M) said, “You know, blowdown is something I never was even focused on; I thought it was a one-time event.” Regarding a system of straight-line winds estimated to be a thousand miles wide, Participant 16 (F) said: “Everybody says it was the largest storm ever, not just in living memory, but that they’re ever aware of, in the Ozarks.”

Some participants noticed shifts in the *seasonal calendar*, which has become less predictable. Weather patterns now include hotter days and lack of cold weather or mild winters. Participant 10 (F), who leads nature programs at a local state park for area youth, said, “I’ve done that program now for 11 years, and this year is the first year I’ve cancelled programs because of the heat.” Participant 13 (M) noted the increase in hot summer days and corresponding lack of cold winter days: “The one thing that's going to happen is, of course, as Missouri starts to get warmer, the summers will be dryer, the winters will be wetter, particularly, and warmer.”

One benefit of mild winters means park visitors are taking advantage of changing *temperatures*, including a lengthened outdoor season, said Participant 4 (M): “It does seem to me that there are more warm days than there used to be. To that extent, being out in the parks and being comfortable or without having to fight off severe cold weather, it's happening more maybe.”

Fig. 2. An early blooming “Harbinger-of-spring” wildflower (participant 13).

3.1.3. Ecosystem effects

All the photos submitted for the project represented ecosystem effects. Further, in the interviews, participants mentioned numerous specific examples of ecosystem effects. Most of these were directly or indirectly caused by weather, although as participant 16 (F) pointed out, direct causation was difficult to tease out and often multiple factors contributed to events such as trees being toppled: “In recent years it was dry and then wet; when it's very, very dry and then you get a lot of water and then you get heavy wind, the combination of crazy weather can really cause problems.”

Impacts to *vegetation* also included changing bloom times, especially early blooming; increased invasive species including garlic mustard and bush honeysuckle; plant diseases; and changes in tree or plant succession. As a volunteer, Participant 13 (M) leads wildflower walks at a state park each spring. In a caption submitted with a photo of a tiny white Harbinger-of-spring flower, he noted it was the earliest date he had seen this particular specimen bloom. “We were amazed at the number of species (10 − 15) already blooming because of the warm February. Many of these wildflowers were one month early” (Fig. 2).

Participant 17 (M) has organized work days to remove invasive plant species in a state park bordering his property. Along with photos of trash bags filled with plants (see Fig. 3), he noted that invasive species have advantages against native plants: “Climate change can indeed weaken native plant ability to compete with the garlic mustard expansion.”

Regarding *wildlife*, several participants mentioned increased sightings of armadillos, which have been migrating northward from the southern states since the 1970s. Participant 14 (F) said, “My personal wildlife climate change indicator is the armadillo. Ever since it started appearing I’m like ‘yep, things are getting warmer.’” Other unexpected animals that participants linked to climate change include wild hogs, badgers, water moccasins, and cougars. Others noticed seeing birds and bugs out of season and an increase in ticks and mosquitoes.

Fish were either less obvious than in the past or dead due to low water conditions. Participant 8 (F) said, “Little by little that water's drying up and then it comes back so it's drought, water, drought, water, and it's killing fish, it's inviting a lot of mosquitoes.” Participant 2 (M) said climate change seems to be affecting fish populations in local streams: “As water is warmed, it becomes less suitable for the native species that have been living in them, and I think we may see less diversity.”

Observed changes in bird migration included more bald eagle and blue heron sightings. Participant 5 (M) said that the first robin of the year was once a noteworthy event, but they no longer seem to migrate: “I’m at the point where I just expect to see robins all year round. They didn’t used to be around all the time.”

Participants mentioned impacts to the *landscape* on several levels,

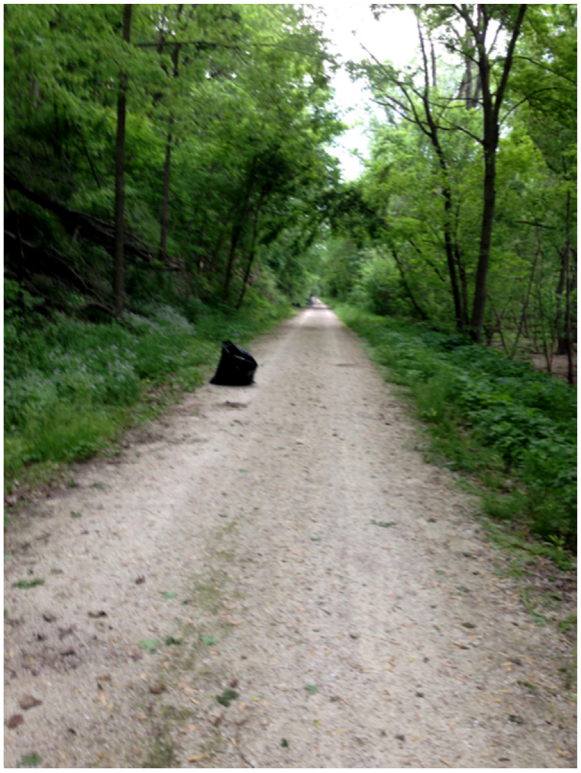

Fig. 3. Invasive garlic mustard collected alongside a state park trail (participant 17).

most notably the damage flooding caused to streams and trees. Participant 5 (M) described a flood the previous winter that "tore up, it washed down banks that were wooded and it took the roots and all out, trees were gone … it's going to start erosion that's going to keep on going. And that's definitely weather related and climate change." Participants also reported increased sand and gravel deposits, along with damage to riverbanks, trails and historic buildings from flooding and storms.

At the other extreme, lakes and rivers showed impacts from low water and increasing algae blooms. Participant 5 (M) discussed the impacts of invasive didymo, also known as "rock snot," a slimy substance that coats rocks in cold streams and rivers that lack nutrients.

> The first time I saw it, it was just a streak of it, it was right below Meramec spring, and it looked like it come out of the feeder stream, and it went downstream and I thought, man what is this? It was just like this brown patch, coming, you could see where it had washed downstream and was growing on all the rocks. It wasn't that many years later it was everywhere. The only time you really don't see it is right after a real hard flood, that kind of turns rocks over and washes things away. But then it seems like it comes right back again.

Participant 12 (F) noted a state park boat ramp closed because of an early drought (see Fig. 4). "This trip was in May; that's kind of early in the year to be having a drought. The lake level was so low, and you can see that normally the lake would be up where the concrete is."

Impacts to trees featured prominently among photographs submitted by participants. These included trees downed or damaged because of wind, ice storms or drought. Participant 16 (F) noted that climate change is expected to increase forest fires: "There could be a lot more fire in the future, in Missouri, wildfire." Participant 2 (M) submitted several photos illustrating damaged trees, noting that while extreme weather events take down mature trees, the unpredictable cycles of climate change are stressing young trees as well (see Fig. 5). He wrote:

> Many relatively young trees with dead and dying branches in the top part of the crown were noted. Although this is not uncommon with older trees that have reached the peak of their life cycle and are in decline, it is much more unusual in young trees. Stress caused by climate extremes (drought, excessive heat, and other extreme weather) can sometimes be too much for even healthy trees and lead to premature decline.

3.2. Role of Missouri State Parks in mitigation

Three themes emerged related to the role of MSPs in climate change mitigation: *Difficult to discuss*, *Education*, and *Management*. Although participants agreed that Missouri State Parks should incorporate climate change in planning and programming, they also acknowledged that park staff members seem to find climate change *difficult to discuss*. Therefore, this difficulty comprises a main theme, along with suggestions for MSP to play a role in climate change *Education* and *Management*.

3.2.1. Difficult to discuss

Several participants mentioned that climate change is difficult to discuss for two major reasons. First, climate change was described as *politically controversial*. Participants described Missouri's conservative political atmosphere as something that makes climate change a volatile topic. Further, they speculated that park employees may be reluctant to address climate change because of pressure from the state legislature or pushback from skeptical park visitors. Participant 10 (F) said: "They're keeping it on the down low because this legislature, they don't want to lose funding." Some participants lamented that park employees seem to avoid speaking out about climate change for fear of becoming targets within their own agencies. Participant 7 (F) said, "They obviously have got jobs to worry about, but if at some point it would be deemed OK to talk about it, politically, not lose your jobs, they should definitely do that. The more voices the better." Participant 13 (M) said, "They're sometimes under pressure to say things the right way, and so that may be why the official naturalists at this point may have to be careful what they say."

More broadly, participants described climate change as difficult to talk about because it is so *overwhelming*. Participant 8 (F) said:

> People don't want to have that conversation is what I discovered. They'll talk about religion, politics, sex, prison, sin, but not climate change. I think it's because some people don't think it exists or maybe they just deny it because I think they think, 'well what can I do about it?' I feel helpless myself. What can I do about it? You know, I join the groups, and our car doesn't use as much gas. You can recycle, but I think the problem is bigger than that.

3.2.2. Education

Despite these challenges, participants affirmed that parks are an appropriate place for visitor education and outreach. Several participants discussed educating visitors by comparing past, current and future landscapes as a way to illustrate the effects of climate *changes over time*. Participant 5 (M) said, "The park rangers and naturalists and even the park historians, they should know what changes are taking place among flora and the fauna, and can compare changes in the way things might be done due to climate change." This participant mentioned a program at a national park in Alaska where glacier melt had been used to illustrate climate change, suggesting that if suitable locations could be identified, a similar technique could be used in Missouri parks to point out differences visitors may not otherwise observe: "It's shocking and I suspect that it won't be that dramatic but I'll bet there are lots of things that they can show in the state parks."

Participant 10 (F) noted that state parks experience a certain amount of natural change over time, but that has been altered by the

Fig. 4. Boat ramp closed due to low water during a spring drought (participant 12).

Fig. 5. A tree uprooted by an apparent windstorm (participant 2).

climate.

> State parks specifically, they are maintaining historical landscapes. They will leave them the same but interpreting how the landscapes are changing, that is something that would relate somewhat to the climate change where we are seeing a change in the successional communities because of climate change. It's hard to link them at this point, but to raise that specter of we are always changing and are they accelerating.

Mindful of the political overtones surrounding climate change, participants noted that any education efforts should be rooted in established science, combined with *on-site data collection* that could provide localized evidence and educational opportunities. Participant 4 (M) said, "I'm sure that it's touchy because of the politics, if parks are perceived as taking a political position, they'll get in trouble, but on the other hand, if they show the science of it, it's hard to argue with that." Participant 15 (M) said:

> I don't know if state parks are doing any biological studies, but there probably are in the Ozark region people looking at those kind of changes, maybe not in state parks per se … Monitoring of our national parks and the effects of climate change is really part of the norm now. Maybe within a given state park, where superintendents have noticed a change in the succession of plant life or species they hadn't seen before or disappear, or the opposite, which we haven't even talked about, which is the disappearing of certain bird species.

3.2.3. Management

Participants said park managers should implement energy efficient improvements and use interpretation to communicate the rationale for these to the public. In other words, make the park system into a *demonstration area*. Specific suggestions included adding solar panels and energy-efficient HVAC systems, building to meet LEED standards, and installing pervious pavers.

State park managers should tackle specific threats, some participants said, including *mitigating invasive plant and animal species*. Participant 5 (M) said, "I think that something they're going to have to watch for more and more is invasives, like kudzu and stuff moving farther and farther north. Fire ants or whatever problems they have down south are going to start affecting us." Participant 2 (M) pointed out that state parks perform a unique function in the wider natural ecology in terms of landscape and woodland restoration:

> The state parks, public lands, land that is managed not for industry, not for income, as a repository for natural resources and particularly the biological resources in the state, fish and wildlife species, native species that live here, there may be ways to manage those lands down the road so as to conserve some of these repositories of some of these native species that live here in the state.

Several participants mentioned the challenges of *protecting natural and cultural resources*, such as watersheds and historic Civilian Conservation Corps (CCC) structures, against threats such as flooding. Participant 7 (F) said, "They need to think about mitigation and look at where they might be vulnerable, the parks themselves. Some may be historic structures, where their parking lots are, are they draining where they should, or are they not draining at all."

Because many Missouri state parks are water-dependent, *protecting water quality* against the impacts of climate change was an interest of several participants, including Participant 15 (M), who suggested upgrading infrastructure by:

> looking at ways to slow storm water by constructing rain gardens and developing natural ways to slow down storm water and to protect the rivers and the streams that run through state parks from storm water runoff, and in building parking facilities in the state parks to make sure that they're developed and designed in such a way as not to increase storm water runoff. Because every state park is within a drainage system of creeks and streams and rivers, and so

> many of the rivers in our state parks are considered to be Ozark treasures and pristine, protect the water quality. For example, down at Montauk where that water treatment facility is, right next to the river? That's something that requires an understanding that if the river should flood, that's going to be very detrimental to the Current River, so being able to look at the design parameters in the state parks as it relates to potential threats to water resources.

Participants also stressed the need to conduct *long-term planning* and make climate change mitigation and adaptation a priority despite other urgent needs. Participant 2 (M) noted, "Conservation is long term, it's not short term. Whether it's on [conservation department] land or park land, either way, it's a long-term mindset." Participant 13 (M) said, "We have to be thinking about decades and centuries… that's why it's hard to get anything done, because there's a lot more pressing issues." Participants said that state parks have a responsibility to protect and increase ecological resilience through managing natural functions. Participant 16 (F) said: "They should be building resiliency into the system. They should be favoring a system that has the capacity to respond, and that includes more natural function, letting the parks respond to whatever changes are occurring in climate."

4. Discussion and management implications

Photo captions and follow-up interviews captured in this exploratory study provided insights into how climate-related impacts on resources and structures will pose challenges to outdoor recreationists in MSPs. Participants noted opportunities to respond to climate change effects in Missouri and beyond, while voicing support for proactive efforts in education and management and acknowledging the political challenges faced by park staff.

4.1. Climate impacts observed

The amount of information about climate change and its highly technical nature often makes it challenging for the average citizen –or indeed, many scientists– to make sense of it all. The relatively small number of photographic submissions, along with interview comments, underscored the difficulty of illustrating climate change effects in Missouri and affirmed previous research revealing a reluctance to attribute shifts in the natural world to climate change (van Putten et al., 2016). This type of reluctance to assign attribution to climate change is thought to undermine communication and present barriers to adaptation efforts (van Putten et al., 2016). However, previous research has validated that visitors are concerned about climate change in parks (De Urioste-Stone et al., 2015) and interested in contributing to adaptation strategies (McCreary et al., 2018). Likewise, participants in this study expressed concern over climate change impacts in Missouri State Parks, both now and in the future. Although participants found climate change impacts difficult to capture in photos and were sometimes reluctant to definitively attribute impacts they saw definitely to climate change, the interviews and photo submissions did correctly substantiate many of the climate-related weather and ecosystem impacts that experts have observed and forecast for Missouri (Anderson et al., 2015).

The frequency of flooding has already increased across the central United States (Mallakpour & Villarini, 2015), including in Missouri. This poses danger to park visitors and strains park budgets. Indeed, the Meramec River in southeast Missouri has undergone historic flooding five times in the past 35 years (Gray, 2017). Floods along the Meramec River in spring 2017 caused the closure of more than a dozen state parks and caused costly damage to campgrounds, roads and other infrastructure (Colburn, 2017), while campers were evacuated in other parts of the state (Garland, 2017). Participants also mentioned concern about an increase in excessively hot days, which are projected to increase in Missouri (Pryor et al., 2014). Warming weather may affect outdoor recreation by boosting visitation to Missouri State Parks in spring and fall while curtailing it during the heat of summer, shifts in the seasonal calendar that could cause management challenges such as visitor crowding and conflicts, along with staff scheduling and operating date mismatches (Jones & Scott, 2006; Perry, Manning, Xiao, & Valliere, 2018). Increased heat could displace some Missourians on vacation, possibly pushing some visitors north. This is a trend identified by other studies, including one that projects Vermont State Parks users will shift their park visitation northward (Perry et al., 2018) and another that predicts American visitation to Canadian nature-based tourism venues will increase 25% by 2025 (Canadian Tourism Commission, 2003). An increase in the frequency and intensity of summer storms (Pryor et al., 2014) could have particular impact on visitor safety and infrastructure damage. An increase in drought (Pryor et al., 2014) threatens Missouri's outdoor recreation in terms of water-based activities such as boating, fishing and swimming restrictions, and negative impacts on wildlife viewing and hunting (Thomas, Wilhelmi, Finnessey, & Deheza, 2013).

Related to the ecosystem, participants discussed numerous locally-relevant changes to wildlife, vegetation and landscape, all of which are affirmed by previous research. Climate change affects and threatens biodiversity in general (Heller & Zavaleta, 2009; Mantyka-pringle, Martin, & Rhodes, 2012; Mawdsley, O'Malley, & Ojima, 2009; Pecl et al., 2017) but may be especially noticeable in Missouri among species with particular importance in the state's parks, such as coldwater fish including trout (Lynch et al., 2016). Missouri's forests (Allen et al., 2010) and other vegetation (Kelly & Goulden, 2008; Vicente-Serrano et al., 2013) face climate change risks from drought and heat.

Most study participants emphasized climate impacts related to a specific activity of interest, such as floating, wildflower observation, or biking. Numerous themes highlighted by study participants could direct targeted communication strategies in Missouri State Parks and Historic Sites. One study participant suggested that Missouri State Parks could emulate Glacier National Park, where interpretive signage shows the impact of receding glaciers, by similarly pointing out climate-change related impacts that visitors may not otherwise notice. The number of participants describing effective climate-change communications at other parks affirms the long-lasting impact of such locally-based messages. This echoes the work of Sharp et al. (2012), which called for research into natural areas visitors that could "inform resource management decisions and develop targeted climate change visitor education programs" (p. 5). The interviews and photographs described in this study demonstrate strong environmental engagement among this group of key informants, lending support to research linking personal connection to natural resources with environmentally responsible behavior (Vaske & Kobrin, 2001).

4.2. Role of Missouri State Parks

A growing body of research affirms the need for data-driven evidence to guide park management in the face of a changing climate (Smith, Brownlee, & Seekamp, 2018). Previous research suggests that park visitors support efforts by park personnel to mitigate the effects of climate change (De Urioste-Stone et al., 2015). Participants in this study similarly support managerial action on climate change adaptation, specifically through education and ecological management. However, many of them acknowledged the challenges managers face due to the controversial nature of climate change. Most Americans see climate change as a divisive issue (Leiserowitz, Maibach, Roser-Renouf, Rosenthal, & Cutler, 2017), with deep divisions among political subgroups (McCright & Dunlap, 2011), especially concerning the level of scientific consensus (Maibach, Myers, & Leiserowitz, 2014) and anthropogenic causation (Bolsen, Druckman, & Cook, 2015). Indeed, Dunlap and Brulle (2015) call for researchers to openly acknowledge and examine the conflicts surrounding climate change to craft some possible solutions.

Work by Ranney, Clark and Felipe (Clark, Ranney, & Felipe, 2013;

Ranney & Clark, 2016) suggests that a short presentation explaining the mechanics of climate change can increase acceptance without any polarizing effects, lending support to the use of interpretive programming in state parks to educate the public using data. Further, Corner and van Eck (2014) recommend engaging the public about climate change by working directly with them to "tell stories about the people and places affected by a changing climate" (p. 16). Results from this study support presenting scientific evidence to the public and framing park-based climate-change communication around specific, locally-relevant resource-related impacts, especially around weather and ecosystem themes that visitors identify as especially salient. Even when they were reluctant to attribute causation, participants cited numerous examples of ecosystem impacts of climate change such as changes in blooming times of spring wildflowers and increases in ticks. Participants suggested that park interpreters could illustrate climate impacts through these types of examples of climate-related changes within MSPs. They also recommended incorporating data collected on site into educational programming as irrefutable evidence of local impacts.

While some study participants expressed difficulty attributing climate change impacts, none espoused outright denial, though this viewpoint no doubt exists among Missouri park visitors. Some experts argue that it is possible to encourage pro-environmental activities even among climate change deniers by focusing education efforts on the social benefits of climate change mitigation, such as encouraging prosocial behavior (Bain, Hornsey, Bongiorno, & Jeffries, 2012). It could be useful to focus natural resource-based climate change education on the broad ecological benefits of environmental behavior. This could include interpretation of some of the management activities already underway, including mitigation of invasive plant and animal species and adoption of energy efficient technology. Such interpretation could provide a springboard for park staff to adopt climate change education efforts, something study participants noted staff seems reluctant to do, even though research has argued for the "unparalleled potential for America's parks and refuges to inspire civic engagement in climate change through place-based communication" (Schweizer et al., 2013, p. 42). Participants indicated their own lack of confidence in climate change knowledge. Indeed, research indicates that even professionals, such as those working for zoos and aquariums, are interested in building capacity to connect climate change with local environmental topics but doubt their abilities to do so (Swim & Fraser, 2014). This supports the importance of educating and empowering park staff to deliver locally-relevant interpretation.

In addition to using parks as demonstration sites for climate-friendly behaviors, participants said park staff should focus resources on directly tackling some of the park system's most pressing threats. For example, because park property is specifically managed for conservation, participants said that parks are key to managing invasive species that pose large-scale environmental concern (Pyšek & Richardson, 2010). Indeed, the U.S. National Park Service has identified locally appropriate invasive species management as a way to adapt to climate change, restore ecosystems and protect cultural resources (U.S. National Park Service, 2017).

Participants also mentioned the need to prioritize water management, including flood mitigation, to protect threatened human, natural and cultural resources. Increased flooding has been identified as a current and future climate change threat across the Great Plains, bringing impacts including physical danger, damage to infrastructure, and threats to water quality (Anderson et al., 2015). Participants acknowledged the many demands stretching park staff and budgets but stressed the need to prioritize long-term climate change adaptation as part of an overall risk management plan (Anderson et al., 2015; Askew & Bowker, 2018; IPCC, 2014).

5. Limitations and future research

Participants reported finding it difficult to find or recognize visible examples of climate change impacts. More participants may have submitted photos had the study instructions been worded to ask them to take photos that would prompt a discussion about climate change, rather than asking for representations or evidence that they did not feel qualified to provide. One successful climate-change related project worded the targeted themes more broadly, asking participants to photograph "what they perceive to be threats" about their vulnerable location (Baldwin & Chandler, 2010, p. 640). Another study asked participants to take photos of "images indicating features of climate change risk" in their neighborhood (Grant, Baldwin, Lieske, & Martin, 2015, p. 28). Other researchers have had trouble getting participants to connect with climate change. In a photo elicitation project intended to examine the interaction of climate change and wetlands, the researchers were surprised that the farmers' photos and narratives were disconnected from climate change. The authors noted, "this was likely a limitation of the method—which focused on the visual—more so than the cohort" (Sherren & Verstraten, 2013, p. 77).

However, one participant reported that being involved in the project made her more aware of climate change impacts. An increased climate change awareness from having participated in the project suggests a potential for engaging future park visitors through engagement such as citizen science projects spearheaded by other agencies and organizations. Also, Shaw et al. (2009) have shown the importance of using locally-scaled visual representations of climate change to educate, engage and activate community members. Future research should investigate and test these methods in state parks and other natural areas.

This study examined a specific sub-sample of MSP visitors used as a proxy for understanding the perceptions of park visitors in Missouri. Further research should expand this work by exploring the perceptions of other visitor and user groups. Further, because this study included only a few parks, future research should expand the geographical scope to gain a broader understanding of statewide climate concerns. Results from this study could guide future research in Midwestern/ Great Plains states facing similar climate impacts.

6. Conclusion

To aid in developing targeted communication strategies, this study identified weather and ecosystem climate-change impacts in MSPs recorded by some members of the MPA. These impacts accurately mirrored those observed and projected by climate experts. Many of them were directly related to specific outdoor recreation activities valued by study participants. The study also identified opportunities for state park managers to take action toward climate change mitigation, education and communication, while acknowledging the difficulty in doing so in a politically polarized atmosphere. Together, these findings support highlighting examples of specific local impacts in climate change communication that occurs in parks. In Missouri, this could include educating the public about threats from flooding, invasive species, and excessive heat. To extend this work, future research should test the relative effectiveness of communication strategies designed to increase environmentally responsible behavior specific to climate change resilience.

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